



A New Forest Pest in Utah: Balsam Woolly Adelgid

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Quick Facts

- The balsam woolly adelgid (BWA) was first observed killing subalpine fir in northern Utah forests in 2017; it is now confirmed in seven counties.
- BWA was first detected in the U.S. in 1908; through multiple introductions and spread, it now infests true firs over most of the country.
- BWA presence is difficult to detect until a tree is heavily infested and displays advanced symptoms (canopy decline, branch and node swelling).
- Management on forested lands is limited due to high cost of control.
- BWA on individual or groups of trees is effectively managed with insecticides applied during the crawler stages; aerially applied insecticides at the forest scale are ineffective.



A subalpine fir stand infested with balsam woolly adelgid.

The balsam woolly adelgid, *Adelges piceae* (Ratzeburg) (Hemiptera: Adelgidae), is a tiny sucking insect that was introduced to North America from Europe. In the U.S., it is a serious pest of true firs in forests, landscapes, and in seed and Christmas tree production. In some areas of North America, BWA has completely removed true firs from forest stands. In Utah, subalpine fir (*Abies lasiocarpa*) is a highly susceptible host tree; white fir (*A. concolor*) is also a host but is more tolerant. Douglas-fir (*Pseudotsuga menziesii*) is not a true fir and not affected by BWA. The USDA Forest Service Forest Health Protection (FHP) team in Ogden first detected and confirmed BWA in the mountains above Farmington Canyon and near Powder Mountain Resort. It is now confirmed in Box Elder, Cache, Weber, Davis, Morgan, Salt Lake and Summit counties. Subalpine fir typically grows at elevations above 7,500 ft, and until now, has been one of the few forest tree species that has resisted large-scale pest infestations.

TREE INJURY AND SYMPTOMS

Subalpine fir is at high risk for attack by BWA in Utah. Vigorous, mature trees 4 inches (10 cm) or more in diameter seem to be most susceptible, but saplings may also be affected. In the West, stem (trunk) infestations are most abundant on sites with higher quality soils and conditions, including lower elevations, while crown attacks occur more often on sites with poorer soils and at higher elevations. Damage is most severe in the first decade of infestation in an area; however, BWA will remain in an affected area indefinitely.

Tree injury is most visible in the fall. Common crown symptoms include:

- initial yellowing, then bronzing, of needles on the inner branches
- the lower crown will die leaving a green top and/or 'top curl'
- abnormal swelling of branch nodes and buds called 'gouting' in response to toxic saliva from adelgid feeding
- woolly material evident near base of tree
- reduced cone production and poor stand regeneration
- reduced growth and stunted trees

Stem infestations tend to be more serious than crown infestations, and can result in wide, irregular growth rings and reddish, brittle wood called 'rotholz'. Host responses to BWA feeding eventually cause decreased water flow to the crown, leading to tree death. Tree mortality typically occurs within 2-10 years of infestation; heavy infestations can kill trees in 2-3 years.

In its native range, BWA alternates between spruce and fir; however, in North America, BWA remains on fir as its European spruce host is not present. BWA populations in North America are composed of females reproducing without mating (parthenogenesis); sexual reproduction requires the European spruce host.



Gouting, abnormal swelling, of fir branches caused by feeding injury from the balsam woolly adelgid.



Subalpine fir tree canopy decline, note dying lower branches and green top leader.

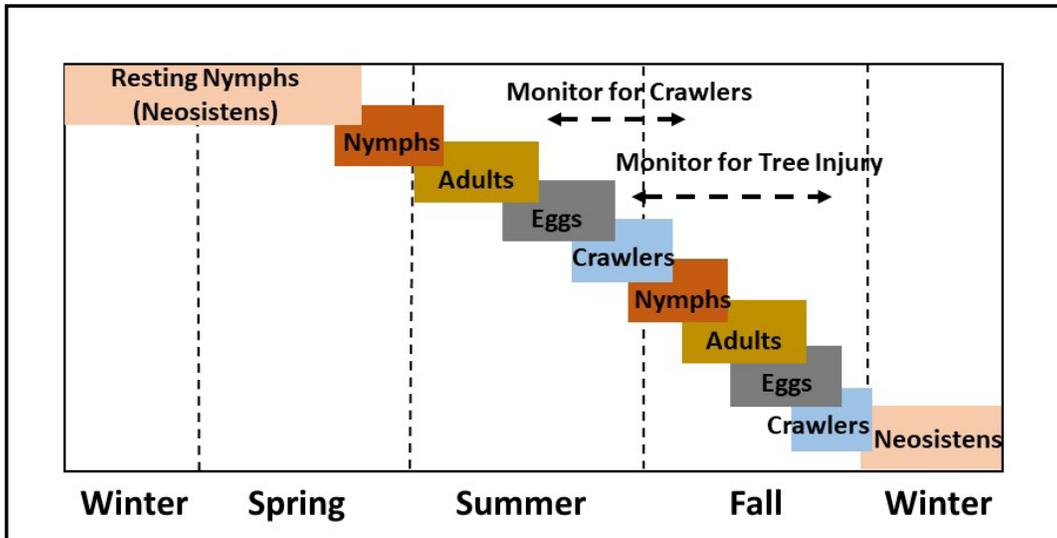


White woolly masses of balsam woolly adelgid on a fir trunk collar.

LIFE HISTORY AND IDENTIFICATION

Two generations per year are most common in the mountainous regions of BWA's range. In cold locations, a resting nymph (immature) stage, called the neosistens, is the only stage that will survive the winter. Spring development begins by May as the overwintering, first-stage nymph develops through two additional nymph

Balsam Woolly Adelgid Life History in Utah



stages, and by late June most BWA are in the adult stage. Female adults are tiny, only about 1 mm long. They are dark purple to black, oblong and wingless. She produces a waxy protective covering called 'wool' over her body and her eggs. These wool patches can be seen on the bark of host trees. Each female produces 100-250 amber-colored eggs during an approximately 6 week period in June and July. Eggs hatch into crawlers (reddish-brown), the only mobile life stage. Crawlers move to new feeding sites on the same tree, or are dispersed longer distances primarily by wind, but also by animals (birds, mammals, humans). Crawlers feed in bark lenticels and in other areas of rough bark, in branch and twig nodes, and at the base of buds. The crawler inserts its mouthparts into the bark to feed and then transforms without molting into the flattened, wax-fringed neosistens. A second generation develops with adults and another egg laying period in the fall. Crawlers hatch and disperse to new feeding sites to overwinter.

MONITORING

In forests, common monitoring methods include aerial surveys to scout for tree stand decline, followed by ground-truthing to identify specific BWA symptoms. Turnquist and Harris (2015) describe a systematic sampling method for signs and symptoms of BWA to estimate the extent of infestation in an area.

In older stands:

1. Examine tree crowns, concentrating on the upper

third, ideally using binoculars. Look for:

- a. Thinning of foliage
 - b. Twig gouting
 - c. Stunted branch and leader growth
 - d. Dead leader
2. Examine recently windblown branches or slash for the above symptoms.
 3. Examine the main stem for presence of white wool (sign of adelgid) up to a 10 m height.
 4. Collect samples of all signs and symptoms for verification.

In young stands:

1. Sample and examine branch nodes from two 2-to-11-year-old branches per tree, from two trees per site.

A BWA dispersal model was developed by Lass et al. (2014) based on wind speed and direction. The researchers found that two-thirds of new infestations in the Northwest could be predicted by wind speed and direction in July and August. Use of the study's model has facilitated selection of ground sampling sites to evaluate BWA spread into new areas, and focus of management efforts.

MANAGEMENT

Cultural Control

Control of BWA at the tree stand and landscape level is generally infeasible due to the high cost of management



Young subalpine fir infested with balsam woolly adelgid; note severely stunted growth.

tools, such as insecticides. At the forest scale, the most effective tactics include:

- sanitation (prevent movement of infested wood and equipment)
- remove infested trees (in winter when crawlers are inactive)
- stand thinning to prolong stand integrity in the short-term
- favor Douglas and white fir, and other tree species tolerant of BWA through selective harvest and planting

Biological control agents in native areas of BWA have been unsuccessful when introduced to North America. A total of 23 predator species were released in North America; 6 predators were established in the Northwest. Despite these efforts, there has been no confirmed reduction in BWA populations from any of these biological control agents.

Several hazard/risk rating systems have been developed to inform forest managers to optimize scouting and management programs for BWA (Ragenovich and Mitchell 2006 ; Hrinkevich et al. 2016). Fir species, site

elevation, soil and site conditions, and stand condition are the primary factors driving stand susceptibility. Adding to the challenge of managing this insect is the lack of market value for subalpine fir; recovering treatment costs through sale of saw logs is infeasible. Transporting infested firewood can result in BWA infestations; Utah's urban areas are particularly at risk. Limiting the movement of infested firewood is a key prevention measure.

Chemical Control

Due to small size, protected feeding sites and the presence of wax around BWA second and third stage immatures and adults, aerial insecticide applications do not provide coverage adequate for management. A thorough insecticide application to individual or groups of high value trees from the ground using a high-pressure system can provide adequate control of BWA in areas such as ski resorts, cabin properties, campgrounds, tree farms and in urban settings.

In North Carolina, successful management of all BWA life stages in Fraser fir (*Abies fraseri*) Christmas tree farms was achieved using a single application of a pyrethroid insecticide – fenvalerate (which has been replaced by esfenvalerate) or permethrin – or insecticidal soap targeting the crawler stages (Hastings et. al, 1986).

In Utah, target crawlers with a residual insecticide, horticultural oil or soap from mid-to-late June through early August, and/or September through early November. Crawlers from the first, second, or both generations may be targeted. Adult and nymph stages will also be affected by applications to the crawler stage.

Specific timing of application to affected trees will depend primarily on temperature, elevation and location - earlier in the valleys and later in the mountains. To properly time application of insecticides to infested high-value fir, monitor for the crawler stage starting around mid-June in northern Utah. Crawlers can be monitored using double-sided tape wrapped around twig, branch (for crown infestation) and bole bark (for bole infestation; thick bark fissures may limit the effectiveness of this on boles of older trees). The presence of tiny orange crawlers stuck to the tape indicate that crawler activity has begun. The use of a beat-sheet (or a piece of white paper) can also be used for monitoring in situations where crown infestations occur. Put the beat-sheet or paper under branches with signs of infestation and strike the branches with a stick. Conduct this test multiple times around a tree in different locations. Look for the



Beat-sheet sample



Scale crawlers on double-sided tape¹

crawlers on the sheet or paper and apply insecticides when appropriate. Timing applications to coincide with peak crawler activity is more important when using soaps or oils, compared to longer-residual chemicals like permethrin.

Be aware of plant injury associated with applications of soap or oil before deciding to apply one of these tools.

Systemic neonicotinoids applied as a soil drench in the early spring after the ground is thawed can provide control of all feeding life stages. This type of insecticide is transported through the sapwood via water uptake. Moderate to severe damage from BWA will reduce water flow within the tree, limiting their effectiveness. Systemic neonicotinoids are best used for new to moderate infestations, or preventively if infested trees are nearby and spread is anticipated.

Commercial Insecticides for BWA (Note: some of the products below are for use only in Christmas tree and nursery production; carefully read the label before purchasing or applying a product.)

- Bifenthrin (pyrethroid; group 3A*; some are restricted-use)
- Esfenvalerate (pyrethroid; group 3A; restricted-use[^])
- Chlorpyrifos (organophosphate; group 1B; restricted-use)
- Dinotefuran (neonicotinoid; group 4A)
- Thiamethoxam (neonicotinoid; group 4A)
- Spirotetramat (tetrone & tetramic acid derivatives; group 23)

Homeowner Insecticides

- Permethrin (pyrethroid; group 3A)
- Imidacloprid (neonicotinoid; group 4A)
- Insecticidal soap/oil (potassium salts of fatty acids; petroleum distillate)
- Sucrose octanoate (sucrose esters; i.e. SucraShield)

*Insecticide Resistance Action Committee mode-of-action groups.

[^]Requires a Utah pesticide applicator license to purchase and apply.

Note: confirmed efficacy of neonicotinoid products for control of BWA is limited; foliar crown applications may better target BWA on limbs and twigs; a soil drench/bark/injection application may better target BWA feeding at the tree base, but efficacy verification is unavailable.

IMPLICATIONS TO FOREST HEALTH

Widespread mortality of subalpine fir is already occurring at some locations in northern Utah. In many cases, there are few other tree species to occupy the growing site. This problem increases the potential for BWA to inflict great ecological damage through increased erosion,

decline in watershed health, loss of wildlife, and reduction in recreational value.

A Utah partnership has been formed to implement survey, research, education and management efforts for BWA. Led by the Utah Department of Agriculture and Food, members represent concerned organizations including the United States Department of Agriculture (USDA) Forest Service; the Utah Division of Forestry, Fire and State Lands; Utah State University Extension; USDA Animal and Plant Health Inspection Service; and ski resorts. This group is coordinating efforts to secure grant funding to study BWA and its impact in Utah, and to develop public educational resources.



Utah partnership of interested agencies and stakeholders attended a tour of balsam woolly adelgid damaged sites in Farmington Canyon, September, 2017.

REFERENCES AND FURTHER READING

- Hastings, F. L., Hain, F. P., Mangini, A. and Huxter, W. T. 1986. Control of the Balsam Woolly Adelgid (Homoptera: Adelgidae) in Fraser Fir Christmas Tree Plantations. *Journal of Economic Entomology*. Vol. 79: pgs. 1676-1680. https://www.researchgate.net/profile/Fred_Hain/publication/233601813_Control_of_the_Balsam_Woolly_Adelgid_Homoptera_Adelgidae_in_Fraser_Fir_Christmas_Tree_Plantations/links/02e7e5315da4c0b04c000000.pdf (5 pages).
- Hrinkevich, K.H., Progar, R.A., and Shaw, D.C. 2016. A severity rating system for evaluating stand-level balsam woolly adelgid (Homoptera: Adelgidae) damage in two *Abies* species in western North America. *Forest Science* 62(2): 181-189.
- Lass, L. W., S. P. Cook, B. Shafii, and T. Prather. 2014. Development of a dispersal model for balsam woolly adelgid, *Adelges piceae* Ratzeburg (Homoptera; Adelgidae), to facilitate landscape-level management planning. *International Journal of Forestry Research*. <http://dx.doi.org/10.1155/2014/519010> (8 pages).
- Oregon State University, Washington State University, and University of Idaho. 2017. Christmas tree (true fir)-balsam woolly adelgid in Pacific Northwest Insect Management Handbook. Accessed online on January 29, 2018. <https://pnwhandbooks.org/insect/hort/christmas-tree/christmas-tree-true-fir-balsam-woolly-adelgid>
- Ragenovich, I. R. and R. G. Mitchell. 2006. Balsam woolly adelgid. Forest Insect and Disease Leaflet 118. USDA Forest Service. <https://www.na.fs.fed.us/pubs/fidls/bwa.pdf> (12 pages).
- Turnquist, R. and J. W. E. Harris. 2015. Balsam woolly adelgid. Forest Pest Leaflet Fo 29-6/1-11993-E. Pacific Forestry Centre, Natural Resources Canada. <http://web.forestry.ubc.ca/fetch21/Z-PDF-pest-info-folder/3316-Balsam%20woolly%20adelgid.pdf> (4 pages).

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¹ University of Georgia Extension, <https://blog.extension.uga.edu/peaches/2017/04/insect-pests-spotted-in-orchards/>

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